Roller Coasters

It is thought that the oldest roller coaster type rides have their origin in Russia and date back to the 1800s. They were sleds supported with wooden **struts** that ran down steep slopes made of ice. These 'Russian Mountains' weren't really able to be used in many other countries as they needed a very cold climate to make and keep the ice frozen. In France they attempted to make these ice slopes but it was too warm, so instead they developed wooden rails that a waxed bottomed sled slid down (similar to a bobsled). In 1885, LaMarcus Adna Thompson was granted a **patent** for the first wooden roller coaster. The basic design hasn't changed hugely since the first coaster opened in New York in 1884, where a specially designed car full of safety features such as harnesses and safety bars travels along a specialised rail track made of many twists, turns, loops and drops. Thompson based his design on a gravity powered railway that delivered coal down a hill. The railway was designed for coal but became a tourist attraction when the owners started charging people to have a ride. His roller coaster was a 180 m long one way track, where passengers boarded rolling benches at the top of a slope and travelled down then up the other side where they stopped got off and boarded a different car on a return set of tracks. This was not a very efficient model and so it was quickly changed to a full circuit oval track. Thompson also held the **patent** for tunnels with different scenes that the coasters ran through such as those found in the Goldrush ride at Rainbow's End.

In the early 1900s John Miller **patented** a unique type of wheel that meant roller coasters could go faster and twist and turn more without the cars jumping off the tracks. These wheels are actually composed of three sets of wheels that clamp the cars to the tracks. This allows modern day coasters to do loops and hang passengers upside down in mid-air.

People love to ride roller coasters because the speeds and angles are always changing rapidly which gives us a unique experience and thrill. Roller coasters are designed to use **acceleration**, **inertia** and gravity to provide this body buzz. Inertia is an object's tendency to either stay still or keep moving at a constant speed in a straight line. These two scenarios can only be changed by a net force. Your body also has its own inertia inside a roller coaster car. When the coaster turns suddenly your body tries to carry on straight but is pushed or pulled so that you travel with the car. As a roller coaster travels along a curved track it is also forced to go round when it wants to go straight. In both cases the force which makes objects travel a curved path is an inwards force called centripetal force. The tendency to go in a straight line (inertia) is what makes us feel like we are being thrown outwards from the car. Centripetal forces can be easily shown with a bucket of water being spun around and around. The water stays in the bottom of the bucket and doesn't fall out because it is constantly trying to go in a straight line but is being pulled off the straight line direction by the base of the bucket which is already going around a curved path.

Formula Rossa

Most roller coasters use basic energy transformations to move them and produce a thrilling ride. As they don't contain engines to drive them along, they have to be given an initial amount of energy to get them going. One method, common to older roller coasters is to winch them up to the top of the first slope. This gives the coaster a large amount of **gravitational potential energy** and when released, this is transformed into enough **kinetic energy** to get the coaster up the next slope and so on. Another method is to use a **launch system** which involves **hydraulics** (pressurised liquids) or pressurised air or an electric motor. These all give the roller coaster a massive push and enough energy to take it up the first slope. From there, **gravitational potential energy** transforms into **kinetic energy**, allowing the ride to continue. Because the wheels of the roller coaster cars have axles and are touching the track as they travel along, there will be **friction**. This means some of the gravitational potential energy is converted to heat and this is why there is less kinetic to carry to the top of the next slope, which therefore has to be lower than the top of the first slope. If a roller coaster is well designed and friction and **wind resistance** are kept to a minimum, the cars will have enough **energy** to complete a long run without stopping.

There are hundreds of roller coasters throughout the world with a wide range of heights, speeds, lengths and number of loops. They provide thrills to millions of people each year. The top five fastest roller coasters are shown below to give a comparison with New Zealand's Rainbow's End roller coaster.

Rank	Name	Country	Top Speed	Height	Launch Type
1st	Formula Rossa	United Arab Emirates	240 km/h	52 m	hydraulic
2nd	Kingda Ka	USA	206 km/h	139 m	hydraulic
3rd	Top Thrill Dragster	USA	190 km/h	130 m	hydraulic
4th	Dodonpa	Japan	172 km/h	52 m	air pressure
5th =	Superman: Escape From Krypton	USA	160 km/h	126 m	motor
5th =	Tower of Terror II	Australia	160 km/h	115 m	motor
n/a	Corkscrew Coaster	Auckland	70 km/h	27 m	chain winch

Data courtesy of Duane Marden, rcdb.com.

There are many features deliberately built into roller coasters to create a thrilling and exciting ride. The twists, turns and sudden drops have been carefully placed and designed to give your body the different sensations you experience on a roller coaster. Fear and the unexpected movements cause a rush of **adrenaline** and make us feel pumped full of energy. Many of our organs and body parts are being pulled, pushed, tugged and squashed in different directions by various forces. Gravity and acceleration are used in a controlled way to produce excitement through the extreme stimulation of our senses.